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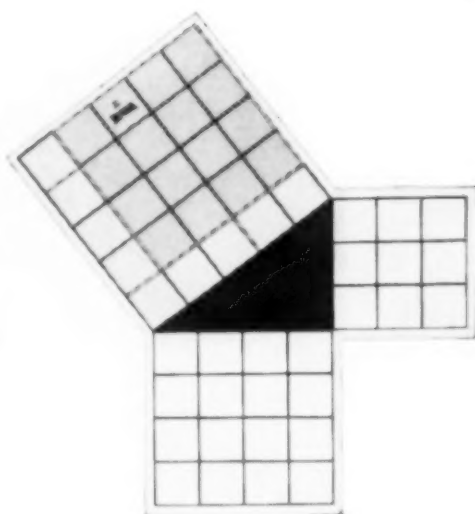
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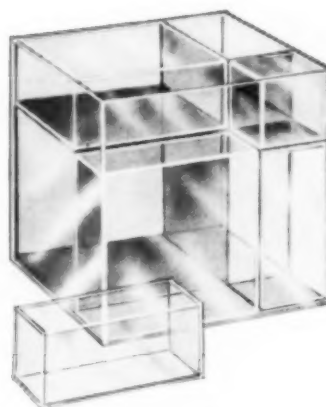
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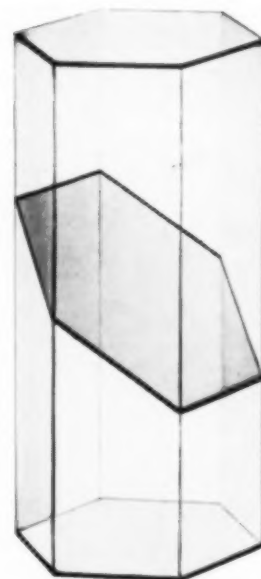
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DUQUESNE SCIENCE COUNSELOR

FOR BETTER SCIENCE TRAINING

Volume XXIV

SEPTEMBER, 1961

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OF SPECIAL INTEREST

In the present issue Dr. Wernher Von Braun, specialist in rocketry at the Redstone Arsenal in Huntsville, Alabama, relates a personal experience in his life as an answer to the question: "What effect has the science teacher had in your life?" The *Duquesne Science Counselor* also posed the same question to Dr. George W. Beadle. Dr. Beadle, formerly of the California Institute of Technology and presently serving as Chancellor of the University of Chicago, has been a Nobel prize winner in biochemistry. His answer will be published in the next issue of the Counselor.

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Pa.

Teachers like to believe that they exert some influence in the lives of their students. To test this belief the Duquesne Science Counselor asked Wernher von Braun to express his viewpoints regarding the teacher who influenced him to the greatest extent. Following is Dr. von Braun's statement:

The Science Teacher and his Students

I am quite sure that the science teacher who most influenced me rather early in life was a gentle, brilliant genius who is still alive today, and who is still an inspiration to me and many, many others.

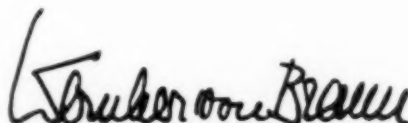
He is Professor Hermann Oberth, a man who has contributed as much or more than anyone to the science of rocketry.

As a teacher Professor Oberth's flawless character and intellectual integrity have always been in abundant evidence.

He understands human values as few men do. And all day long, every day, his great humanity and consideration for his fellow man shine brightly.

It was Professor Oberth's book, "The Rocket to The Interplanetary Spaces," that first made me want to study rocketry and the exploration of space.

How fortunate I was to have had Professor Hermann Oberth as my teacher and mentor.



DR. WERNHER VON BRAUN, *Director*
George C. Marshall Space Flight Center
National Aeronautics and Space Administration
Huntsville, Alabama

Wernher von Braun was born in Wirsitz, Eastern Germany on March 23, 1912 and received his Ph.D. degree from the University of Berlin in 1934. He came to the United States in 1945. From 1937 to 1945 he was technical director of the German Rocket Research Center at Peenemuende in the Baltic Sea and was responsible for the development of V-2 long Range Rocket. From 1945 to 1950, he was technical advisor at White Sands Proving

Grounds and project director at Fort Bliss, Texas. Since 1950, von Braun has been director of the Guided Missile Development Division at Huntsville, Alabama, specializing in rocket design, rocket control, development of large liquid fuel rockets and rocket power plants for rocket planes and guided missiles. He is a member of many societies and author of many technical articles.

Blood Types, the RH Factor and Transfusion

BY SISTER MARY PULCHERIA, C.S.S.F.

Our Lady of the Sacred Heart High School, Coraopolis, Pennsylvania

Transfusion of blood has been regarded as a recognized and legitimate operation in obstetric surgery since the year 1824, when Dr. Blundell published his well known work entitled, *PHYSIOLOGICAL AND PATHOLOGICAL RESEARCHES*. The operation had, however, been vaguely known to the medical profession for the last four centuries. There are obscure allusions to it in the Roman poets, which seem to indicate that it was practiced as early as the Augustan Age.

The earliest authentic case on record is that of Pope Innocent VIII who was unsuccessfully given a transfusion of blood from a young boy in 1492. In June in the year 1667 Denis of Montepellier injected the blood of a calf into the veins of a young man who was weakened by repeated hemorrhages. The first transfusion restored him to perfect health. His subsequent experiments, however, were not so successful. In November of the same year, an English physician, Richard Lower made similar experiments transfusing the blood of sheep and calves into human beings which seemed to have been successful. These were repeated in the following year in Italy by Riva and Manfredi. Most of the later attempts to transfuse whole blood of animals into humans were unsuccessful. Later physicians restricted the source of their blood supply to human beings. Despite these restrictions, more patients into whom blood was transfused died, than survived.

Prior to World War II, most blood transfusions were performed directly from donor to recipient. This practice was inefficient because it often involved difficulty in locating a donor of the proper blood type at the necessary time. During World War II surgeons developed techniques of removing whole blood from a donor, treating it with an anticoagulant and storing it in sterile containers under refrigeration. By this method blood could be preserved for about a week. Improved methods of blood processing, particularly the elimination of coagulants by the ion-exchange technique subsequently extended the storage time to three weeks. Processed blood is available at blood banks set up by hospitals and such agencies as the Red Cross.

Since the danger to life in the loss of blood from an injury or operation or at childbirth is not primarily in the loss of blood cells, but in the dropping of blood pressure caused by a diminished volume of blood, it is not always necessary to transfuse whole blood. The body possesses an immense reserve of red cells in the spleen and liver; it can draw upon these sources in an emergency. The value of a blood transfusion, therefore, lies primarily in its restoration of the blood volume, pressure, and normal circulation. Plasma or serum has, therefore, come into very wide use as a transfusion fluid. Plasma has certain definite advantages over whole blood, except in cases of anemia, in which it cannot be substituted because of the need of erythrocytes, and in the disturbances of blood coagulation, in which whole blood is more efficacious. Plasma does not cause agglutination of the transfused patient's corpuscles; it is universally compatible and no blood grouping is required. It can be dried and stored in containers, and thus be ready at hand for almost immediate use. All that is necessary is the addition of sterile distilled water to dilute it to the desired concentration. Moreover, the plasma of about fifty donors is pooled in order to avoid a high concentration of any particular agglutinin.

If more than forty per cent of the blood is lost over a short period of time, the body is usually unable to repair the loss unaided. Some artificial means of replacing the lost fluid is necessary. Although plasma will restore the blood volume, whole blood from another person is the ideal transfusion fluid for it is capable of restoring not only the blood volume but also furnishes erythrocytes for immediate use as well.

Even though the red blood cells of all normal human beings have an identical appearance, they are not all chemically alike. This was demonstrated first by Landsteiner in the year 1900. The red blood cells were shown to contain two types of antigens or agglutinogens. These were designated as Type A and Type B. These antigens have a capacity of combining with other materials, antibodies or agglutinins found in the plasma of an individual. This reaction causes a clumping of the red blood cells, and is

called agglutination. Like a lock and its specific key, each agglutinin in a red cell can be acted upon by its specific agglutinin. It is obvious that the plasma of an individual with Type A cells cannot contain antibodies for A, or the cells would clump. Therefore, Landsteiner after studying the reactions between the antigens and antibodies in blood, found that human beings can be divided into four large groups according to the presence or absence of the antigens found in the red blood cells. The individuals who contain antigen A, have type A blood; those with antigen B, have type B; those with both antigens, A and B are in the AB group; while those who lack both antigens, are in the O group. The serum of each of these groups contains an antibody for other groups but not its own, thus:

Type	Antigen in RBC	Antibody in Plasma	% in U.S.
A	A	b	40
B	B	a	10-15
AB	AB	none	5
O	O	a and b	40-45

FIG. I

The blood types can easily be determined by mixing blood typing sera and whole blood from an individual on a slide and observing the results. Two small drops of whole blood are placed on a clean slide which is divided into two halves by a vertical line drawn through the center with a glass marking pencil. The letters A and B are placed in the upper corners of the slide and the initials of the individual whose blood is being typed in the lower right hand corner. A drop of .9N saline may be added to each. Then a small drop of Anti-A blood typing serum is placed on the drop of blood marked A, and a drop of Anti-B serum is placed on the drop of blood marked B. Each is thoroughly mixed with a separate toothpick or applicator and observed after two minutes. The type is read from the results as shown below.

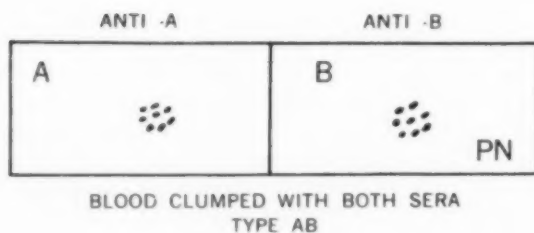


FIG. II. Slide Technique

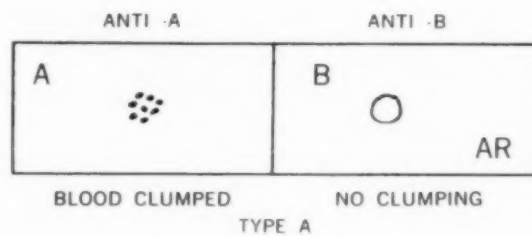
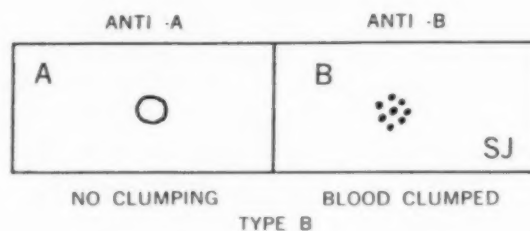
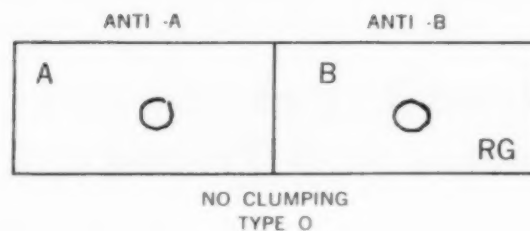


FIG. III

It is apparent that if a blood transfusion is needed, the most advantageous situation would be to have both the donor and the recipient of the same blood type. If, however, such blood is not available, any type may be used as long as the red cells of the donor are not agglutinated by the serum of the recipient. Since the cells of a type O individual have neither A nor B antigen, this type of blood may be given to any of the other types provided other foreign antigens are not introduced. The blood cells will not clump. An O type individual, therefore, is sometimes designated as a universal donor. Conversely, since type AB does not contain antibodies for A or B, such an individual can receive blood from any other type. A type AB individual, therefore, is sometimes called a universal recipient.

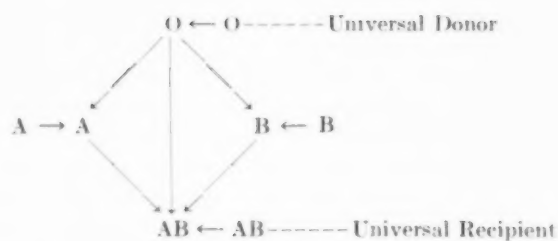


FIGURE IV

In general, in blood transfusions, it has been demonstrated that the character of the donor's plasma is unimportant as regards the presence or absence of the a and b antibodies. Ordinarily, it is the character of the donor's red blood cells in regard to the presence or absence of the A and B antigens and their reaction with the recipient's plasma, a and b antibodies, which determines whether a given blood transfusion is likely to be safe.

The blood groups are definitely inherited according to Mendel's laws and are the same for all races of men. The percentage of various types, however, differs among races. Apparently there are three sets of alleles for the AB types.

Further work on blood groups indicates that additional alleles exist, resulting in subgroups of group A. Furthermore, antigens A and B are found in two chemical forms. In some individuals they are soluble only in alcohol, but in others, they are also soluble in water. Individuals having water soluble antigens are known as "secretors", while those not having them, are "nonsecretors". The "secreting" ability is inherited on the basis of an autosomal dominant gene.

Two other independent antigens were also discovered in 1927 by Landsteiner and Levine. These were named M and N factors. Unlike antigens A and B, no natural antibodies against them were found in the human serum. The antibodies must be artificially produced by injecting the antigens into rabbits. Since no natural antibodies exist, these antigens need not be considered in making blood transfusions. By means of artificially produced antibodies, however, each person may be readily classified into one or another of types M, N or MN. The results may be helpful in solving medico-legal problems involving dubious parentage. The MN blood types appear to be inherited as if three multiple alleles were operating. There are two genes which produce two types of N antigens /N₁ and N₂; N₂ is very rare/, and one gene which produces the M antigen. Neither of the genes is dominant. Therefore, the presence of both results in the production of M and N antigens. Every person has either one of these genes or both; no one has yet been found who lacks both of these genes in his red blood cells.

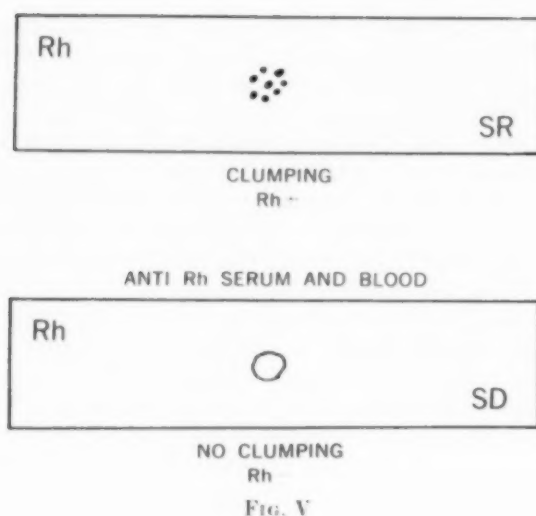
Other subtypes of blood have also been discov-

ered. These include the P and S types. Extensive studies by Landsteiner, Wiener, Levine, Race, Taylor and others have shown that another important series of antigens is also present in the blood of human beings. The antigen is commonly called the Rh factor because the antibody was originally developed in rabbits and guinea pigs by injecting them with the red blood cells of *Macacus rhesus*, the rhesus monkey. When the anti Rh agglutinating serum was tested against rhesus monkey red cells, it caused clumping in all cases. However, when this serum was tested against human red blood cells of people in New York, it caused agglutination only in eighty-five per cent of the individuals. These were said to be Rh+. The remaining fifteen per cent whose blood did not clump upon the addition of the anti Rh agglutinating serum, had no Rh antigen, therefore, were called Rh-. Unlike the blood groups A, B, AB, and O, which are present in various percentages in all races, there is a great deal of variation in the percentage of presence or absence of the Rh factor. Certain races, e.g., the North American Indians, Chinese and Japanese are from ninety-nine to one hundred per cent Rh+ while Negroes are about ninety-five per cent Rh+. Since human serum does not ordinarily contain the specific antibody against the Rh antigen, test serum is obtained from animals in which the antibody has been carefully developed.

It is important to realize that if the antigen of an Rh+ individual is introduced into the blood of an Rh- individual by transfusion or otherwise, the Rh- blood is capable of forming antibodies against it just as it normally does against a foreign protein. No serious reaction follows one such transfusion. If, however, two or three transfusions of Rh+ blood are given to an Rh- recipient, agglutination of the donor's red blood cells may occur because the anti Rh is built up in the recipient's serum. Such clumped blood cells will produce serious reactions and even death because the precipitated hemoglobin may block the tubules in the kidneys. For this reason, before blood transfusions are given, the Rh condition should be determined just as the blood types are checked and the history of previous transfusions should be noted.

This can be done by using the same technique as in blood typing except saline should never be used. It interferes with the antibody reaction; it has a blocking effect upon it. The slide should also be heated to body temperature and observed after five minutes.

The Rh factor also explains the cause of a disorder of newly born infants called erythroblastosis foetalis. Since the Rh factor is inherited as a dominant trait, half or more of the offspring of an Rh+ father and an Rh- mother will be Rh+. When the developing



foetus of this combination results, it is possible that trouble may follow. Normally the blood of the mother does not come in direct contact with the blood of the foetus, but occasionally a very small number of red cells apparently do get into the maternal circulation, perhaps by the accidental breaking of small capillaries in the placenta. Once the Rh+ blood cells get into the mother's circulation, the Rh antibody is produced by her. Since this antibody is present in the serum, it can easily diffuse through the foetal circulation causing damage to the red cells of the developing foetus. Such a child may be still-born, or if born alive, may be highly deficient in red blood cells. This results in severe jaundice. Unless immediate treatment is given, it will die. The child may be saved by numerous blood transfusions of Rh- Type O blood during the first few weeks of life.

This situation, however, is not as serious as it might appear. This is attested by the small number of children born with this disorder. This is due perhaps to the fact that very few cases of pregnancy from such a genetic combination result in a mixing of the foetal and maternal blood. Furthermore, not enough antibody is generally produced to cause trouble in the first pregnancy so the condition does not usually appear until the second or subsequent offspring are developing. Since only fifteen per cent of the Caucasian race is Rh- and only five per cent of the Negroid and only one per cent or less of other races, the chance combination of an Rh+ male with an Rh- female is greatly reduced.

Taking into account not only the usual main groups /A, B, AB, and O/ and the subgroups, but

also the Rh factor, over 2500 different varieties of blood have been found.

It is obvious, therefore, since the blood types of individuals vary so much, great precautions must be taken before a blood transfusion can be given. Since all humans have some type of antigens and antibodies in their blood, the blood typing technique can be used very effectively in class to demonstrate the typical antigen-antibody reaction which occurs in living things. Because these blood types are transmitted according to the laws of heredity, this topic may stimulate interest in the study of Genetics.

As teachers we are in a unique position to enkindle the spark of interest in students entrusted to our care and direct their attention to the vast treasure of unsolved problems associated with the chemistry and physiology of blood. As dedicated teachers let us pass on to younger hands the zeal, the interest, the spark of true scientific curiosity by being ever ready to encourage, to stimulate and to indicate the wide fields of scientific interest to those entrusted to us as students.

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Excellence in Elementary Classroom Teaching

BY GLENN O. BLOUGH

Past-President N.S.T.A., Professor of Education, University of Maryland

As teachers of children in the classroom how excellent can we be? The solution of this problem depends among other things on our preparation, our teaching environment and on our intentions. Each of these has many facets. Here we can consider only a few. Who knows if they are the most important? This, of course, is impossible to say but certainly they are among the first considerations when we think of excellent teaching. The word science has purposely been left out of the title. The elements of excellence are the same in any elementary-school teaching.

First you are as excellent as your understanding of science and what it is. What is it? A method of discovery. A body of organized subject matter. A way of thinking.

You cannot teach science unless you know science any more than you can teach arithmetic if you can't add, subtract, multiply and divide. You cannot teach science unless you know it any more than you can teach the Westward Expansion in social studies without at least knowing some fundamentals about conditions at the time, the people, why they went, what happened on the way and after they arrived. This is not meant to infer that you must know all of the answers to all of the questions children can ask about the given area of science you are teaching. Science teaching does not consist of the teacher answering the children's questions anyway. You do however need to know enough about the subject to help plan sensible activities, to take the lead in identifying thoughtful problems to solve and to work with children in locating appropriate reading and experimenting materials and other learning aids.

You cannot wait to learn your science with the children. To do so will probably result in aimlessness and inappropriateness and frustration for all concerned. After you have once provided the leadership necessary to launch a good science experience you may be heard to say, "George I don't know that but together we can all find out." But you need to know more than George does (1) to know if the question makes sense (2) to know how to lead him and his classmates in a successful endeavor.

You as an elementary teacher also live in an age of science. You yourself need to know at least as much as an educated layman knows about his environment. You need this in order to read periodicals,

to have some understanding of the scientific phenomena that surround you and to react more intelligently in a scientific world. Some knowledge of science will keep you out of some nonsensical deep water, and increase your chances of achieving excellence in your teaching.

The meaning of science as a method of discovery must also be understood by the excellent science teacher. Discovering involves doing some purposeful things that are directed toward solving a problem. It means experimenting, reading, observing, asking, discussing and any other method appropriate to the problem solving situation. Discovering involves profiting by mistakes. It involves growth in the skills of learning. The excellent teacher expects children to grow in ability to discover for this is the spirit of science.

Second you are as excellent as the product of your teaching. Sir Humphry Davy is supposed to have said: "My greatest discovery was Michael Faraday" (his assistant and student). We as teachers may well ask ourselves: "How excellent are we when measured by the knowledge, attitudes, appreciation and interest of our products."

Because of our science teaching our pupils should have certain information, interests, appreciations, skills and attitudes that they would otherwise be without. How skillfully we accomplish our objectives depends on how well we aim. Except by sheer accident a target is never hit without careful aim. The greatest single factor essential to excellence in teaching may well be the teacher's understanding of her aims and her skill in identifying problems and directing learning to solve them that will accomplish the aims. Skill in problem solving, development of scientific attitudes, increased interest and appreciation and knowledge of science are not automatically achieved by hit and miss science teaching. They are achieved by the teacher who says "As soon as I have identified my purposes I've committed myself. Everything that happens in my classes from then on must contribute in some way toward the attaining of these purposes—otherwise I'm wasting time. It may be a slow process but each day I must inch along in a prescribed direction." Such an attitude forces us to challenge our selection of problems to solve, our teaching methods, our activities, our assignments and our evaluation.

How excellent is our product? As excellent as we

intend it to be. Are our children successful because of us or in spite of us? Do children look forward to science classes? Do they see science on Saturday? Do some of them, because of our excellence in teaching, decide to explore the possibilities of science as a career? Do others live more fully and with greater interest in their scientific world? These are questions every science teacher bent on excellence asks himself.

You are as excellent as the learning climate of your classroom. Creating a learning situation in which children will want to learn, are challenged, are encouraged and are expected to accomplish something is a large order. All of us have had teachers who could do just this. All of us have had teachers who couldn't or didn't.

What makes children want to learn? There are many answers to this, some obvious, some subtle. Some children learn when they can see how useful the learning is. Some learn because they are challenged, some because they find pleasure in accomplishment, some because they catch the spark of enthusiasm from their teachers who have the creativity to think of interesting and challenging ways to begin. The excellent teacher gives much thought to what motivates learning and each year increases in ability to bring about greater zeal to explore and learn.

What makes a good learning climate? Again there are more answers than we can set down. But perhaps if we as science teachers can answer "yes" to the following three questions, our classrooms are excellent learning labs.

Are the children in my classes free to ask questions?

Traditionally we seem to give greater recognition to children who know answers than we do to those who have asked searching questions that indicate thoughtful concentration. We have all been in classes where asking questions was not the practice except by the teacher.

Are the children free in my class to express their opinions? Whenever their opinions reflect their best thinking, pupils should know that such expression will be acknowledged with the consideration due it. The opinion may be without much merit but if it's honest it's appropriate. If it's wrong the student will see his error but this should be without embarrassment—some terribly intelligent people have been wrong! We have all sat in classes and only listened because this pleased our teachers most.

Are pupils free in my classes to say "I don't understand"? If pupils have been giving undivided attention and show evidence of real effort, they should feel free to ask for another explanation. We have all sat in classes thinking that everyone but us understood an explanation only to discover after class that our colleagues didn't understand

either. Why didn't we speak up? Could it have been because the climate wasn't conducive to a second explanation?

On the surface these three questions may seem too elementary to be important. Thoughtful consideration however may reveal that some aspects of excellence are not realized because honestly we must answer "no" to such questions as these.

No one can be excellent by himself. The teacher who is trying to reach a state of excellence is entitled to a certain amount of help, some of which is currently lacking in many school systems. In summary here are some of these needed helps:

a. *A planned course of study* that meets the needs of the learner. Such a course cannot be made by pooling the inexperience of a group of local teachers. It must be built on the experience of successful teachers, on research, on existent courses of study and bulletins and then made to fit local conditions through in-service meetings of teachers and administrators and finally through use by teachers. With such a planned course the teacher can anticipate her needs and prepare for teaching with increased effectiveness. Even with this plan there can still be opportunity for valuable incidental teaching, children's questions and pupil planning.

b. *Intelligent supervision.* It is as impossible for a principal or supervisor to be helpful to a teacher if he knows no science and can't recognize good science teaching, as it is for a teacher to teach science if she doesn't know any. Teachers deserve intelligent supervision in science just as they do in reading or any other area.

c. *Books and other materials to work with.* Text books and supplementary books, appropriate materials and apparatus must be available. A catsup bottle and ball of string along with advice to "make your own materials" are not enough. Many pieces of apparatus currently being purchased for elementary school science are valuable for secondary school but inappropriate for the use by small children and frustrating to teachers who scarcely know which end of the apparatus is the base.

d. *Appropriate University and College content and methods courses.* A physics course for engineers has different objectives and content than one intended to equip an elementary teacher to see and interpret physics in her environment and to share her learnings with 10 year olds. Science methods courses taught by persons who have not been in an elementary school since they were children are not likely to be very helpful to teachers preparing for elementary teaching. Teachers deserve courses in science content and methods designed to fit their needs.

(Continued page 86)

"In the beginning God created. . ."—Genesis.

The Synthesis of Amino Acids... under possible primitive earth conditions.

BY MR. RICHARD P. AULIE

Evanston Township High School, Evanston, Illinois

I.

In the spring of 1960 two of my students in advanced biology successfully synthesized amino acids and simple sugars in our high-school laboratory.* They used a modification of Stanley Miller's now famous experiment at the University of Chicago. A mixture of hydrogen, methane, ammonia, and steam were subjected to electric discharges of 60,000 volts for 50 hours.

At the conclusion of the procedure a yellowish liquid, called an "organic soup", remained in the apparatus. Chromatographic and mirror tests were applied to this residue. Positive tests for amino acids and aldehydes were thus obtained, providing conclusive, qualitative evidence for the success of the experiment.

II.

The experiment is an imitation of the conditions that may have prevailed on the earth during the creation of life. Herein lies the significance of the experiment. According to modern theory, given initial impetus by the writings of Oparin, and later by the laboratory techniques developed by Miller, Urey, et al, the early atmosphere was oxygen-free. It rather contained large amounts of hydrogen, ammonia, and methane, mixed with water vapor. For millions of years this gaseous mixture was subjected to ionizing radiations such as ultraviolet light, electric discharges from atmospheric storms, cosmic rays, and radioactive particles emitted from substances undergoing degradation in the earth's crust.

As a result of these radiations, so goes the theory, the gases were broken into ionic fragments with a subsequent re-grouping into simple organic molecules, among which would be the essential amino acids and simple monosaccharides. These compounds were washed into the primitive sea, collecting into a sort of nutritious organic soup.

The creative process then continued under definitive autocatalytic conditions. Then, particular organic, complex compounds were polymerized that

would have precise self-sustaining properties, all based on the sociability of the carbon atom. Among such would have been various nucleotides, proteins, and assorted carbohydrates. These undoubtedly collected into loose aggregations called coacervates, held together by electrostatic attractions. We may speculate that these coacervates may have been the precursors of cellular structures.

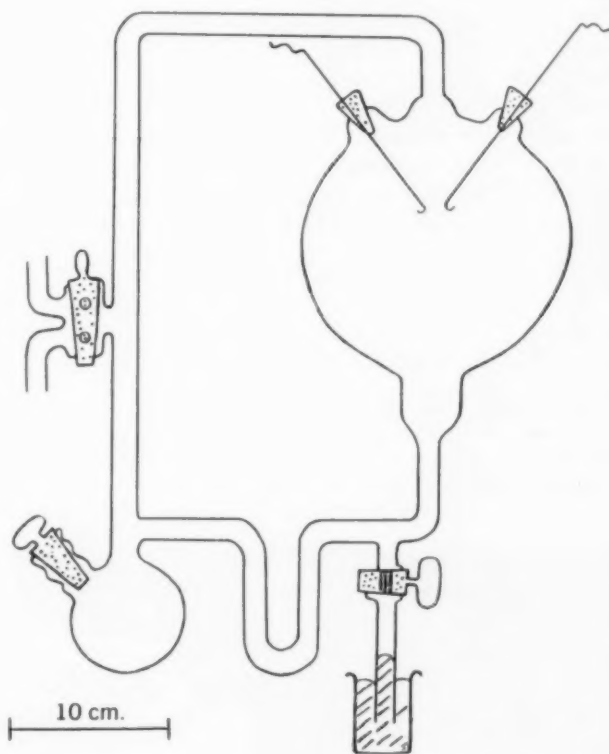


Fig. 1. The glass apparatus. Water is boiled in the smaller sphere to promote circulation of steam and gases. The "soup" collects in the U-tube and also in the smaller sphere; the mercury dip-leg, lower right, acts as a safety valve. Adjusting distance between electrodes determines the voltage discharged in the larger sphere.

(Continued page 92)

* The work was done at Bloom Township High School in Chicago Heights, Illinois by Mr. Dennis Harper and Mr. Jerry Levi.

Science Projects and Exhibits—Grade Six

BY HELENE C. LORD

Home Economics Department Continental Baking Company, Boston, Massachusetts

The true purpose of a science fair, or exhibit, is to motivate a creative interest in developing projects and experiments, to achieve scientific accomplishment, not science fairs per se.

A sixth grade science project and exhibit, such as was inaugurated in Connecticut by Continental Baking Company, is an excellent example of education and industry working together to accomplish a creative and valuable learning experience for science classes. The esteem gained by the project is a direct result of the fine contribution and assistance of Connecticut educators and the dignified conduct of the sponsoring company. This project is now being used in other areas in the United States.

The idea originated in the Home Economics Department of the Continental Baking Company, Rye, New York, with the publishing of its science notebook "All About Growth for Grade Six" in "Grade Teacher" magazine. This notebook, available in quantity includes lessons and instructions for experiments in several phases of growth, rocks, minerals, bacteria, photosynthesis and animal and human synthesis. Planned for Grade six, it correlates with science and social studies covered at this grade level.

FIG. 1. First Place Trophy is presented by Mrs. Helene C. Lord, science fair director, to Bruce Donnelly and Christine Asselin. Youngsters, who studied "Microbes in Action", are students of Mrs. Elizabeth Veilleux (center).



The rules for the project and exhibit are that classes study "All About Growth", visit the local Wonder Bakery and work in groups to prepare a project for exhibit. Rule sheets also include suggestions for projects. Suggested project categories are those areas studied in sixth grade and are a real help to teachers.

During the past three years, sixth grade students have shown so much enthusiasm and creativity that they have developed many additional projects that include many phases of science. Projects showing the use of magnets, thermometers, or the six basic machines in industry, controlled experiments in hydroponics, photosynthesis and animal synthesis for health and growth, effects of microbes in action, the story and behavior of yeast—all are so fascinating to student that doors are opened to a new world of wonder, motivating curiosity and awareness of science as it affects every day experience.

At this grade level, group work in science is an important introduction to work that students must do in later years as individuals. The sixth grader, naturally enthusiastic, finds the drama of being part of a science team appealing and exciting. They select a project, organize and collect material and prepare an exhibit or experiment, under the supervision of the teacher, in the classroom.

Where there is a Wonder Bakery, employing a home economist or a plant hostess, it will probably sponsor a project. These people are trained to present programs on science and nutrition as part of the plant tour, making the field trip a valuable learning experience. The industrial field trip that offers a real contribution to the multi-sensory experience trains the student to form discriminating and efficient research study habits.

Judges are usually directors of science departments at colleges, offering a teacher training program, as they are best qualified to evaluate work done at the elementary level.

In 1959, when the project was pioneered, the directors of college science departments and curriculum supervisors in public and parochial schools generously offered their assistance, drawing on their many years of experience in elementary science, to develop a program of real value. Suggested project categories are those studied at sixth grade level and are a real help to teachers.

Teachers are advised of the method of scoring ex-

DUQUESNE SCIENCE COUNSELOR

hibits in order to work toward a realistic goal. Sample score cards are available before beginning project. Completed score cards are returned to teachers after evaluation of exhibits.

During the exhibit, culminating the project, students have the experience of learning to communicate their knowledge to others as they take turns explaining their work to visitors to the exhibit.

Recognition for work accomplished has an important place. Certificates, indicating first, second, third awards, and honorable mentions, are given. A trophy is given to the class winning first place and cash awards for the purchase of science equipment is given to classes winning the first three places. Certificates of merit go to all participating classes and individual award cards to each student.

Newspaper, television and radio coverage add to the feeling of recognition for a job well done. Newspapers give advance notices and news coverage including photographers at the exhibit. Local radio and TV stations schedule spot announcements and time on interview programs. In Connecticut, Channel 30, WHNB-TV, took films that were shown on their newscast and later at the 1961 NSTA Convention in Chicago, as were films taken by Richard Morton, Audio Visual Director, West Hartford Public Schools and Screen News Digest.

Training teachers in some areas are required, as an assignment, to visit the exhibit to select a project to use in developing a unit at another grade level. Lesson plans, mimeographed in quantity, are available at each exhibit.

The achievement of sixth grade classes is remarkable in that the work done is truly their own. When given proper motivation and opportunity, they achieve outstanding creativity in science establishing a criteria well worth emulating by science classes at other grade levels.

Industry, because of its highly developed research laboratories, has much to offer in the way of industrial aids, especially services and material, to education.

The author suggests the following as possible exhibits for the class to construct and display.

Possible Exhibits

- (1) **PLANTS NEED SUNLIGHT TO MANUFACTURE FOOD:** The starch they manufacture is stored in stems, leaves, roots and seeds for man's use. Demonstrate how we can tell that sunlight is necessary to the manufacture of starch. Exhibit three stages.
 - (a) A potted plant with one leaf covered with a black envelope.
 - (b) An uncovered plant showing the blanched leaf.



Fig. 2. Students of St. Justin's School in Hartford, Conn. with their exhibit summarizing their project of mice and nutrition.

- (c) Test tubes showing how leaves were boiled in alcohol, and the end result showing leaves tested with iodine of both covered and uncovered plants.
- (2) **PLANTS NEED MINERALS FOR GROWTH:** We need minerals to help our bodies grow properly, and many of these minerals we get from plants. A class hydroponics project can be built with improvised hydroponics pans. There should be a controlled specimen which has received no minerals, another which has received minerals.
- (3) **ANIMAL EXPERIMENTATION:** Cages, charts and records as described in the Science Unit. Emphasis should be placed on the scientific method used and the care taken in recording findings.
- (4) **MAKING THERMOMETERS:** Part of the success in good baking is proper temperature. Set up and make as class projects any one or all of the following: a liquid thermometer; an air thermometer; a metallic thermometer. (Refer to *Science Teaching Today*, Vol. 4, "Experience With Heat", National Science Teachers Association—NFA.)
- (5) **GRAIN OF WHEAT:** Make a large cut-away model of a grain of wheat, based on the drawing in the unit. The model can be made of papier mache, plaster of Paris, or clay. Various sections should be appropriately labeled.
- (6) **THE STORY OF BREAD:** This display could include charts, drawings and actual loaves of bread. First, a chart of cardboard, with cellophane packets containing the ingredients needed for making bread—yeast, flour, salt, sugar, shortening, etc., properly labeled. Next, enlarged drawings of the sponge and the yeast cells which caused the bread to rise. Lastly,

(Continued page 92)

The Preparation and Use of Plant Enzymes in a Quantitative Approach in High School Biology

BY SISTER M. PIUS, S.S.C.

Maria High School, Chicago 29, Illinois

Purpose

- To introduce enzyme dynamics
- To have students prepare enzyme extracts and to experiment with them
- To develop concepts of control, catalysis, colorimetry, volumetrics, concentration, specificity
- To pursue a quantitative approach to biology
- By inductive method to have students discover the basic properties of enzymes

Introduction

A perusal of biology laboratory manuals reveals that enzyme studies seem limited to the enzymes of the human digestive tract. It is strange that such life-specific substances as enzymes should receive only passing recognition in high school biology and be so subjective in approach. The plant world, on the other hand, is more objective and extremely accessible.

The following investigation may be conducted in conjunction with the study of the cell, it may evolve along with the study of plant growth and development, or provide a perfect motive for a field trip.

The general idea is to prepare crude extract by macerating plant material with water, filtering it through cotton and noting its diastase activity on soluble starch solution. It is important, however, to establish the principle that all living things produce enzymes. Hence, prior to embarking upon a quantitative venture, the qualitative must be confirmed by experiment.

A lead question might well be: "Do all cells produce enzymes?" Have the demonstrating students macerate animal tissue in water (for example, grasshopper legs, frog muscle, fish muscle, beef tissue, chicken liver, etc.) in a mortar, filter it, then add soluble starch. Allow to stand and test for starch with Lugol's solution. A comparison with the control will be very convincing.

Teacher Preparation

A. PREPARE THE STUDENT.

Assign reading from textbooks, general reference material, and specific periodicals to acquaint the student with colorimetry, enzyme activity, chemical change, effects of temperature, nature of proteins, diastase activity, catalysis, etc.

B. PREPARE THE REAGENTS.

Soluble Starch. Add 0.4 g. of soluble starch to 100 ml of water. Warm and stir until it dissolves.

Lugol's Solution. Dissolve 10 grams of potassium iodide in 100 ml of distilled water, then add 5 grams of iodine. For sensitive testing, dilute with water using one part of solution to ten parts of water.

Colorimeter. Fill six test tubes with water and using bluing and black ink tint the water to match corresponding stages of reaction in 0 to 100% concentrations of enzyme-starch reactants.

C. PROVIDE EACH GROUP WITH A SET OF THE FOLLOWING SUPPLIES.

1. Plant material (may be supplied by the student)
2. A mortar and pestle with sand for abrasion
3. Four or more baby food jars and labeling for
 - a). the crude enzyme extracts
 - b). water for dilution
 - c). Lugol's solution
 - d). soluble starch
4. A funnel and cotton for filtering
5. A 25 ml graduated cylinder
6. Four or more medicine droppers
7. A stand with eleven test tubes (one pyrex) for experimenting
8. A colorimeter
9. A set of enzyme variants
 - a). 10% salt solution
 - b). 10% hydrochloric acid
 - c). 10% sodium hydroxide
 - d). A source of heat and refrigeration
 - e). A source of light if sunlight is unavailable
 - f). A source of radioactivity

D. SUGGEST THE FOLLOWING PLANT MATERIALS FOR COMPARATIVE STUDY.

1. Different species of plants used entire
2. Parts of the same species of plant: seeds, stems, etc.
3. Same parts from different species
4. Monocots vs. dicots; Annuals vs. perennials
5. Seedlings vs. mature plants of the same species
6. Water plants vs. land plants
7. Algae, bacteria, mushrooms, mosses, ferns, evergreens, angiosperms
8. Fresh plants vs. dehydrated plants
9. Ripe fruit vs. unripe fruit

E. HAND OUT THE FOLLOWING DIRECTIONS TO THE STUDENT.

1. Label the containers: WATER, ENZYME, SOLUBLE STARCH, LUGOL'S SOLUTION and fill them with the corresponding material from the supply table.
2. To insure uniformity of concentration of the enzyme extract, it will be necessary to control the ratio of plant material to water. Measure the volume of plant material by water displacement and add two more volumes of water.
3. Using the pestle macerate the measured volume of plant material and water. Filter the resulting suspension through cotton into the bottle labeled ENZYME. If your laboratory has a centrifuge, centrifuge the suspension for five minutes at 1000 RPM. Use only the supernatant liquid.
4. Observe the colorimeter. All colorimeters are based on color difference detection. In advanced work an electric eye is used to detect and record the amount of light absorbed by the test solution. Your colorimeter employs your own eyes for detecting color difference. It consists of six test tubes of graded colored solutions representing concentration differences. The deepest color indicates no chemical change, and is the CONTROL. The uncolored one, complete chemical change. To use this colorimeter it will be necessary to label the colorimeter tubes. Mark the deepest color 0, the next, 20, 40, 60, 80, and 100. This will represent the per cent of chemical change. Be sure to enter these data on your record sheet during the experiment.
5. Plot your data as you progress, using enzyme concentration on the horizontal axis and per cent of reaction on the vertical axis. (Note-Figure I)
6. Label each of the eleven test tubes 0%, 10%, ... up to 100%.
7. In each of the eleven test tubes place the following to make up the indicated enzyme concentration.

Conc.	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Drops of Enzyme	0	1	2	3	4	5	6	7	8	9	10
Drops of Water	10	9	8	7	6	5	4	3	2	1	0

8. Carry out the desired tests, carefully timing each reaction for 30 seconds or more.

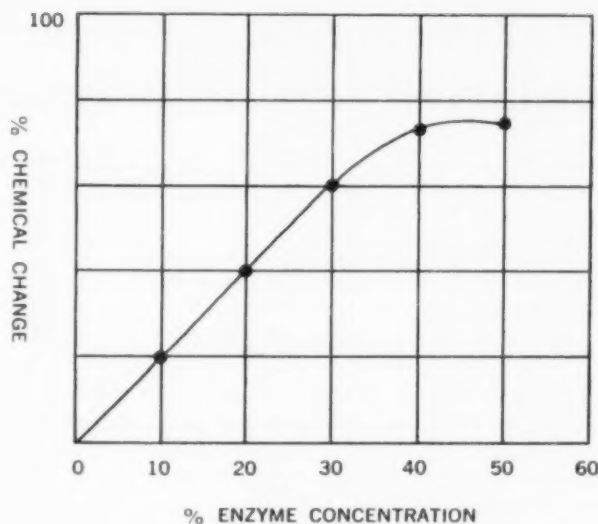


FIG. I

9. The following routine can be followed for each concentration or variant thereof:
 - a. Add five drops of soluble starch. Time.
 - b. Stop reaction with Lugol's solution.
 - c. Dilute with cold water, filling the test tube to $\frac{1}{2}$ inch from the top of the test tube.
 - d. Compare with colorimeter. Record the data.
 - e. Plot the data on graph paper.
- F. SUGGEST THE FOLLOWING VARIABLES FOR STUDYING THE EFFECT OF TEMPERATURE, pH, RADIATION, OR SUBSTRATE SPECIFICITY.
1. Use 5 drops of 10% NaOH, HCl, or NaCl with the enzyme before adding the starch solution.
 2. Boil the enzyme before adding the starch solution. Vary temperature.
 3. Freeze the enzyme before adding the starch solution.
 4. Expose the enzyme to strong sunlight, or radioactive substances.
 5. Try different substrates, such as protein, fat, instead of starch.

G. FOLLOW UP AND TEST.

A committee of students representing one member from each field of investigation could summarize, discuss, and crystallize conclusions.

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Relativity in Elementary Astronomy

BY KENNETH W. WISZOWATY

Philip Rogers School, Chicago, Illinois

Introduction

The modern day pupil is taught to visualize the world in terms of concrete objects and absolute standards. This approach often produces a certain mental set which categorizes information in terms of absoluteness. For instance, the idea of time is undoubtedly regarded by most pupils as an absolute quantity. But upon examination we find that time is prone to slow down when influenced by such factors as motion and gravitational mass.

Time has been compared to a river which has a uniform current flow for all points along its banks. Therefore time has always been considered to be constant for all observers along the river. However, the Special Theory of Relativity shows that time is relative to motion. And the General Theory states that gravitational mass has a slowing effect on time.

Experimentally, the gravitational mass effect was demonstrated by J. C. Adams, an English astronomer, as early as 1925. Adams' measurements showed that B Sirius, a white dwarf star, exhibited a frequency shift toward the red end of the spectrum. As light is caused by the vibration of many different atoms, if the frequency is lowered due to the gravitational mass there should be a shift to the lower frequencies in the visible spectrum. The shift will go to the red end because the frequency of the color red is lower than that of the other colors in the spectrum.

To plunge a pupil into a bath of "shifting frequencies" and "time dilations" is neither fair nor sensible. To better explain concepts of the relativity of time and motion, energy and matter, a groundwork for the acceptance of relativity must first be laid.

There are numerous examples of relative quantities: weight, size, distance, and direction, to cite a few. After gaining a backlog of relativity experiences, the pupil is better prepared for an attack on time and motion.

In the following examples the theme of relativity is applied to basic facts in astronomy. The purpose for doing this is to wean the pupil from his adherence to absolute quantity, while building his fundamental knowledge of astronomy.

Relative Sizes and Distances

A logical starting point in astronomy is our own solar system. The first example of relativity is a calculation of the relative sizes of the planets and the sun. (see table)

After going through the relative sizes, it follows that the relative distances between the planets should be calculated. When the measurements are completed, a scale model can be constructed and the pupils will be able to see these relative quantities.

This exercise will give the pupil an appreciation of the relative size of our solar system. The measurements may be extended to galaxy size and intergalactic distances.

Planet	Approx. Scale Diameters	Approx. Scale Distance from Sun
	<i>in.</i>	<i>in.</i>
Mercury	$\frac{1}{2}$	$\frac{1}{2}$
Venus	1	$\frac{3}{4}$
Earth	1	1
Mars	$\frac{1}{2}$	$1\frac{1}{2}$
Jupiter	11	5
Saturn	9	$9\frac{1}{2}$
Uranus	4	19
Neptune	$3\frac{1}{2}$	30
Pluto	$\frac{1}{2}$	39

Planet scale 8,000 miles:1 in. Distance Scale 93,000,000 miles:1 in.

Relativity of Direction

The concepts of UP and DOWN are particularly rigid to pupils. UP is always overhead and DOWN is always at one's feet. But if a person in North America points to his feet and declares this to be down, what about the man in Australia who is also pointing toward his feet to show the direction DOWN?

Of course, both directions are DOWN, and both parties are correct.

To easily illustrate this seeming paradox, have the children imagine a path of DOWN right through the center of the earth. It will be easy to show that DOWN continues until the center point of the earth and then reverses direction as we pass the center of gravity. If we were to jump in, we would fall DOWN

to the center of gravity, and then once passed the center we would be "falling" UP. Actually the directions of UP and DOWN are relative to the center of gravity.

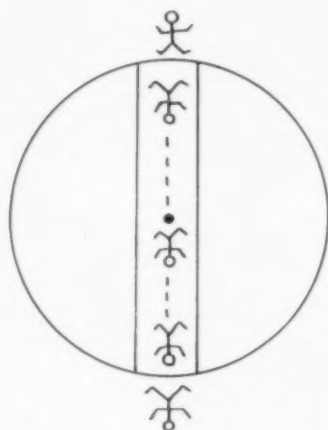


FIG. I

Relativity of Weight

The concept of weight is interesting to exploit. To most pupils weight is an absolute quantity that can only be varied by dieting. In this exposition, the teacher can bring two concepts into play:

1. The effect of mass on gravity. (the greater the mass, the greater the gravitational field)
2. The effect of gravity on mass. (the greater the field, the more the mass weighs)

By transporting the pupils, imaginarily of course, to various planets, one can demonstrate that the planets have differing masses and differing gravitational fields. And because weight is merely a function of the gravitational pull on mass, one can show weight change.

The Relative Weight Change of a Hundred Earth Pounds

	lbs.
Earth's Moon.....	16
Venus.....	85
Earth.....	100
Mars.....	30
Jupiter.....	264
Sun.....	2,789

Relativity of Motion

Suppose we draw a straight line on the board. (see figure IIa) Most pupils will agree that it is a straight line. At this point we announce to the pupils that we will demonstrate how the line is not straight at all.

Once again we depart from the usual procedures, and ask the pupils to use their imaginations to move themselves to the center of the earth. From our new position, the straight line is making a circular path. (see figure IIb) So we now agree that it is circular in nature.

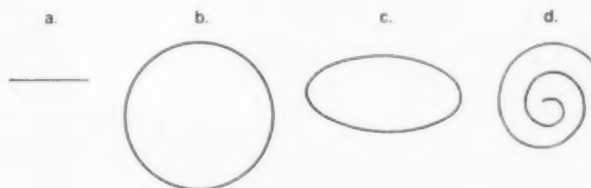


FIG. II

Making another imaginary move, we go to Mars and view the line. From our new vantage point the line assumes the shape of an oval. (see figure IIc) Our straight line becomes an ellipse. By now the children will be waiting for the next excursion, so we jump out of the galaxy. The line now is converted into a spiral. (see figure IId)

The explanation is that when we were at the center of the earth, we became a non-moving point around which the line rotated. On Mars we observed the line as the path of the earth's orbit. And while we were extra-galactic, we saw the path of our solar system's rotation in the arms of our pinwheel galaxy.

Another instance of relativity of motion can be illustrated by a boy riding a bicycle and throwing a ball up and catching it as it falls.

To the boy, the ball goes straight up and down. This is because he is riding at the same forward velocity as the ball.

To a non-moving observer on the curb, however, the ball makes an arc. The non-moving observer is cognizant of the boy's forward motion plus the ball's upward motion. The resultant vector is in the form of an arc because of the effect of gravity pulling the ball downward.



FIG. III

(Continued page 86)

PLEASE ACCEPT OUR
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Ten minutes spent with any of these three UNITRON Student Microscopes will tell you more than we could say in ten thousand words. That's why we'd like to invite you to try one — or all three — for ten days . . . FREE. The only thing you have to invest is the next 5 minutes . . . to find out what's in store for you in top-notch performance and added advantages.

WHAT'S THE DIFFERENCE? At first glance, the printed specifications on all student microscopes look the same. You might well ask "What's the difference — if any?" Here are the facts.

Even many of the largest manufacturers feel that optical and mechanical short cuts are quite acceptable in microscopes designed for the school or college laboratory. Therefore, they design their microscopes with lower-resolution objectives, without condensers, and often simplify mechanical construction. In contrast, UNITRON Student Models MUS, MSA, and MLEB are designed to give regular, professional performance, with no compromise in image quality.

THE LAWS OF OPTICS HOLD FOR STUDENT MODELS TOO

For a beginning student, any enlarged image seen through the microscope will appear exciting. But isn't it just as important to see a correct image? A true picture? Magnification without resolution is empty . . . the image appears blurred and details are fringed with diffraction lines in much the same way as a faulty TV picture. That's why UNITRON doesn't offer a 'student series' of objectives which, though named to imply "achromatic", still let color and aberrations in through the back door. All UNITRON Student Microscopes are equipped with the same professional-type objectives supplied on our more expensive medical models. Because our high-dry 40X objectives and condensers each have a numerical aperture of 0.65, the student can enjoy the same quality image at 400X or 600X that the medical student sees through his more expensive instrument.

WHY A CONDENSER? In microscopes using 'student series' objectives, the omission of a condenser may not be too serious, because there is really no high numerical aperture, or resolving power, to be realized. But all UNITRON Student Microscopes have a 0.65 N.A. condenser to utilize the high resolution of our professional quality objectives. We also provide an adjustable iris diaphragm (not merely a disc diaphragm) to control light reaching the condenser. All these extras work hand in hand with UNITRON's anti-reflection coated optics to produce an image of optimum contrast and clarity.

WHAT STAND DO YOU TAKE? Teachers and students want easy operation, durability and adaptability. And that's just what UNITRON Student Microscope Stands are designed to give. Positive and smooth coarse focusing is by a diagonal-cut rack and pinion. A simple counter-twist of the knobs gives easy tension adjustment to meet any preference. A separate and independent fine focus with full range of travel has a precision micrometer screw to assure sharp images.

Now — about the microscope stage. For precise movement of the specimen at 400X and higher, UNITRON offers a quick, easy way of attaching a reasonably priced mechanical stage. (Some manufacturers offer this feature — but only on their higher priced models.) All UNITRON Student Microscopes have stages pre-drilled and tapped to permit future addition of a precise, but inexpensive (\$14.75) mechanical stage. The large stage of Models MUS and MSA also acts as a bumper, projecting beyond the objectives and nosepiece to prevent accidental damage.

SOMETHING NEW HAS BEEN ADDED.

All UNITRON Student Microscopes now have built-in focusing stops that prevent accidental contact between the objective and specimen slide. This reduces repair costs for objectives and prevents slide breakage. Without the stop, it is easy for beginning students to pass through the critical point of focus, not even realize it, and ram the objective into the slide. The new stop also saves time and temper by automatically placing the image in approximate focus. Student guesswork is eliminated.

NEW 10X WIDE FIELD EYEPIECE

Student microscopes are often chosen with at least two eyepieces, usually the Huygens type . . . a 5X for its large area of view, and a 10X for the magnification needed for critical observations. Now, our new coated 10X Wide Field eyepiece combines both these features in one eyepiece — a large field and the desirable 10X magnification. Teachers will like it: one eyepiece is more convenient than two. There's no chance for the extra one to become lost or damaged. And, it's slightly easier to use the Wide Field eyepiece because of its longer eye relief — you don't have to get your eye so close to the lens. Model MUS is now regularly supplied with this new eyepiece, but it's optional on Models MSA and MLEB, too.

ATTACHABLE SUBSTAGE ILLUMINATOR.

A snap-fit illuminator that attaches by means of the regular mirror mount, this new accessory eliminates any need for mirror adjustments or an outside light source. Even when the microscope is moved or inclined, the illuminator stays in alignment. It combines correct light intensity with convenience. Operates on regular 110-115V. current. The housing is rotatable 180° to give a choice of two types of illumination: bull's eye condenser for concentrated light or plane condenser for diffuse lighting. Built-in blue filters give daylight quality. Cost? — only \$10 as an accessory (less an allowance for the regular mirror if you don't need it.)

MEETS C.C.S.S.O. REQUIREMENTS . . . AND MORE.

UNITRON Student Microscopes more than meet the general requirements outlined in the Council of Chief State School Officers Purchase Guide. Our microscopes are available with either three or two objectives. Models with two objectives are supplied with a triple revolving nosepiece (with removable plug in the extra aperture) so that you can add another objective when you want it, without the extra expense of changing nosepieces.

CAN YOU AFFORD NOT TO BUY?

Check some of the prices listed in other suppliers' ads and literature . . . then look at ours. UNITRON saves you real money. And, if you're in the market for several instruments, new quantity discounts make our prices even lower . . . 10% for 5 to 10 and even higher discounts on larger quantities!

WHY NOT TRY ONE? If you are planning to buy microscopes, now or for your next budget, please accept our invitation to try one, or all three, UNITRON Student Models in your own laboratory, at our expense. Let UNITRON prove itself to you before you decide.



\$75 each

UNITRON STUDENT MICROSCOPE MODEL MUS

EYEPIECE — Coated 10x Wide Field
OBJECTIVES — Achromatic coated 5x (10NA), 10x (25NA), 40x (65NA)
SUBSTAGE — .65NA condenser, iris and mirror
PRICE — \$75 each (or \$67.50 each in lots of 5-10)

With two Huygens eyepieces — choice of 5x, 10x, 15x — price is \$74 each, (or \$66.00 each in lots of 5-10). Substage illuminator available in place of mirror or as accessory, at slight change in price.



\$107 each

UNITRON AUTO-ILLUMINATION MODEL MSA

EYEPIECES — Coated Huygens 5x, 10x, 15x
OBJECTIVES — Achromatic coated 4x (10NA), 10x (25NA), 40x (65NA)
SUBSTAGE — .65NA condenser, iris, filter holder, built-in transformer and high intensity illuminator
PRICE — \$107 each (or \$96.30 each in lots of 5-10)

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The Undergraduate Research Program at Rosemont College

BY MOTHER MARY LEO, S.H.C.J.

Rosemont College, Rosemont, Pennsylvania

It is with a real sense of gratitude and satisfaction that I report to this particular group on the progress of the research program at Rosemont College. Three years ago at Mount Mercy College the topic of our annual meeting was also concerned with undergraduate research programs. The formal talks given then as well as the informal discussions afterward made the impossible seem possible. Plans made that spring and summer on the basis of suggestions by P.C.R.T.S. members started us on a program which has gathered momentum each year. I hope that a review of the obstacles we faced, the program which evolved, the grants which actualized the plans, and the advantages we have derived will stand as a tribute to the effectiveness of the Round Table for mutual help and perhaps will stimulate someone else who is still holding back from launching an undergraduate research program.

Limited space, a non-existent budget, and, above all, the crowded time schedules of both faculty and students in the department loomed as permanent obstacles, even before thought was given to feasible problems to be investigated. At the Round Table in 1958, we learned that the Research Corporation in New York and the Sigma Chemical Company in St. Louis considered a worthwhile problem more important than a budget, and that both organizations would help an initial venture.

The Chairman of our Chemistry Department recalled many unanswered questions that had been raised by her own doctoral research on enzyme kinetics. The equipment used was simple enough that the physical chemistry laboratory could supply almost every basic item. (Triply distilled water and pyrex glassware untouched by cleaning solution were the major additional requirements.) We realized that a problem, or problems, within the scope of undergraduate investigation was *not* a difficulty.

Space to set aside for the work was the second obstacle to melt away when confronted with determination. The analytical chemistry stockroom boasted running water and electrical outlets. By moving supplies for analytical chemistry in with those for physical chemistry, a research lab *could* be created. As many as four students could work comfortably

there at one time—but where in an already crowded liberal arts curriculum were to be found chemistry majors with time to devote to research? And who, in an essentially “two-man” department, was going to direct their efforts?

Unsuspected solutions came this time from the Dean of the College (formerly a member of the Chemistry Department!)—why not ask now for the laboratory instructors whose need was already becoming pressing, even without a research program? And why not offer the research elective to Seniors on a variable credit basis depending on how much time each one could afford? The administration proved encouraging; the students, enthusiastic; and so, we faced the last hurdle—the non-existent budget.

However, we now had a plan of action which could be described—on paper, at least. The form of application for a grant from the Research Corporation of New York is simplicity itself: the title of the problem, its significance, the plan of procedure and the requested budget require fewer than two typed pages. The program which we outlined in this first quest for funds was forseen as two or three years' work, but the only request was for the equipment not already on hand: mostly glassware, and five-liter all-glass stills for making triply distilled water.

Chapter One of our research story at Rosemont ends with the awarding of this initial grant of \$900.—the direct result of the boost we received from this same Pennsylvania Catholic Round Table of Science.

The time was ripe for beginnings that school year of 1958–59. Four enthusiastic Seniors began work in September. All attended a weekly seminar on the general topic of enzyme kinetics and from two to six hours a week in the lab. Once basic techniques were mastered each launched on an individual project related to, but distinct from, the others. Each student had ample scope for literature search, for struggling for reproducible and self-consistent results, for studying and supplying modified methods when needed, for recognizing blind alleys and accepting negative results, and for suggesting theoretical explanations of the observed reactions. Moreover, because of the unified general theme of their work, even the pioneer group was able to progress to a point where signifi-

cant correlations could be observed among the separate sets of data.

Interest and enthusiasm for the program had already been sparked among the underclassmen by this group when the National Science Foundation announced its Undergraduate Research Participation program with the possibility of stipends or grants-in-aid for the participants. For several of the best qualified Juniors this possibility was a vital one. As scholarship students at the College, the nominal five-hours-a-week service which they returned, was just enough to keep them from having time for research. Under the N.S.F. program, they could spend the five hours a week in research and still reimburse the College at the same nominal rate as before. In addition to those receiving college scholarships, there were those who worked at outside jobs to help finance their education, and so could not afford to spend additional hours in the lab. Since these comprised the very groups of students whom N.S.F. aimed to help, an application was filed for the academic year 1959-60.

N.S.F. applications are not the simple two-page affairs that satisfy the Research Corporation, but thanks to that New York foundation, we now had a working program to describe to the government foundation. Well-defined norms to determine those eligible for stipends were outlined, though participation in the research itself was not limited to those receiving stipends. The application was successful* and we late-comers to undergraduate research found ourselves on the first list of grantees under the N.S.F. program. The new budget did not include the cost of providing equipment for double the number of student participants. We hoped that the Research Corporation would underwrite this expansion, and it was a real set-back when they interpreted the award of the N.S.F. funds, which was for stipends only, as (quote) "support from another source." Nevertheless we began the next year with eight participants, whose time in research varied from two to eight hours a week in addition to the weekly seminar-conference.

Changes in the curriculum for the following academic year and an unusually small number of Senior chemistry majors seemed about to place the program in jeopardy when N.S.F. placed its minimum academic year requirement for research participation at ten hours a week—a contribution quite beyond the capacity of the most energetic liberal arts student. For the first time we gave thought to a summer research program such as that suggested by the modified N.S.F. proposal. Would our students be willing to work full-time for a minimum of ten weeks during the summer—without academic credit? The response from the students was overwhelmingly in the affirmative, but the application for eight stipends was pared

* \$2085. awarded, Spring 1959.

to four by N.S.F. as a condition for awarding the grant.† The genuine enthusiasm of the eligible students was impressed on us all when they themselves proposed to reduce their own remuneration in order to extend the grant to at least six instead of just four of their own number.

The fact still remained that several capable and interested scholarship students would be excluded from the academic year program because of necessary work commitments unless we could find another source of funds for stipends, grants-in-aid, or research scholarships. Once again, a suggestion offered at a Round Table meeting proved to be a way out of the dilemma. At Immaculata College in 1959, the Petroleum Research Fund was cited as a likely sponsor of small research projects involving undergraduates. Although not apparent at first glance, the possible remote role of enzymes in the genesis of petroleum from organic materials provided sufficient connection between our work and petroleum research to warrant an application to P.R.F. for the needed academic year funds. The award of this grant‡ provided for the necessary material expansion, but above all, secured the continuity of the work and the valuable training in research of several eminently qualified students.

Renewed applications this winter, and the renewal of both grants this spring** brings us up to date in our story and has guaranteed a future for our project. There are, and will continue to be practical problems of administration as well as of procedure, but the value of the program to the students and to the department greatly outweighs the difficulties. Here, with only slight modification is how we summarized our convictions in two of our progress reports to the N.S.F.

Experience has decided us on the project type of undergraduate research in preference to several isolated problems. The large project provides the good features of the isolated type and has added specific advantages. Thus, in either case, each student has her own definite problem; she must meet and resolve difficulties which arise; she must try to formulate theoretical explanations of her results as well as to plan further work. When the individual problem is also one facet of a larger area being investigated, there is the opportunity to work as a member of a team. At regular meetings, results as well as difficulties are shared and new ideas are explored together. Often a discussion of a problem not immediately related to one's own can lead to a clarification of some obscure or puzzling aspect of it. All gain confidence

† \$3250. awarded, Spring, 1960.

‡ \$2800. awarded, Spring 1960.

** N.S.F. \$3250. for Summer 1961.

P. R. F. \$5600. for Academic Years 1961-62, 1962-63.

(Continued page 94)

Growing beans and wheat by a nutrient solution with and without component elements was a project performed by the fourth grade of St. Andrew Avellino School in Flushing, New York.

Culturing Angiosperms by Hydroponics

BY SISTER M. BEATRICE, O.P.

St. Andrew Avellino School, Flushing, New York

Master Lesson Plan Followed

(Reference: Fourth Grade Manual, *Science and Living in Today's World*, Doubleday, 1959.)

1. PROBLEM
 - A. General Aims for the Project.
 - B. Specific Aims for the Project.
2. MATERIALS
 - A. Listing of Actual Materials Used (detailed).
 - B. Explaining the Use of the Materials.
3. PROCEDURE
 - A. Outline of Details of the Experimentation.
 - B. Details Related to Specific Science Concepts.
4. OBSERVATIONS
 - A. Generality in Light of General Aim.
 - B. Specific Observations of Results of Experiment.
5. CONCLUSIONS
 - A. Principle or Law Derived from Experiment as Result of *Observations*.
 - B. Concepts Learned.

Master Lesson Plan

(Motivation Lesson for this Unit of Work)

1. PROBLEM: Culturing angiosperms by hydroponics
 - A. General Aim: To answer the question—
 1. Where do we get our food?
 - B. Specific Aims: To answer the questions—
 1. By what process is energy from the sun (ultimate source of all energy, except atomic) transformed into a form of energy which can be used by animals?
- $\text{CO}_2 + \text{H}_2\text{O} + \text{sunlight and chlorophyll} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + \text{H}_2\text{O} + \text{O}_2$
2. What elements are necessary for development of green plants?
 3. How do plants grow from seed to seed?

2. MATERIALS:

Molar solutions of KNO_3 , KH_2PO_4 , $\text{Ca}(\text{NO}_3)_2$, MgSO_4 , KCl , CaCl_2 , NaSO_4 , NaH_2PO_4 , NaNO_3 , $\text{Mg}(\text{NO}_3)_2$; a solution containing 10 grams FeCl_3 and 10g tartaric acid per liter; a micrometabolic element solution containing

H_3BO_3	5.0g	
$\text{MnCl}_2 \cdot 4\text{H}_2\text{O}$	3.0g	
ZnCl_2	0.2g	per 2 liters
$\text{CuCl}_2 \cdot 2\text{H}_2\text{O}$	0.1g	
MoO_3	0.1g	

washed sand, distilled water, plastic or paper flower pots (definitely not clay plots) seeds—tomato, tobacco, bean, castor bean, wheat.

3. METHODS OR PROCEDURE:

Nutrient solution(s) are prepared as desired according to the following table:

solutions used and (# if ml)

Solution Desired	KNO_3	KH_2PO_4	$\text{Ca}(\text{NO}_3)_2$	MgSO_4	KCl	CaCl_2	NaSO_4	NaH_2PO_4	NaNO_3	$\text{Mg}(\text{NO}_3)_2$
complete...	2	2	3	2						
without K...			3	2				2	2	
without Ca...	2	2					2			3
without Mg...	2	2	3				2			
without N...		2		2	2	3				
without P...	2		3	2	2					

to each l of solution prepared add 1 ml of ferric tartrate solution and 1 ml of micrometabolic element solution.

Note: If only a complete solution is desired, only six stock solutions need be prepared. A control solution is suggested consisting of only distilled water.

Reference: Meyer, Bernard S. and Donald B. Anderson. 1952. *Plant Physiology*. pp. 473-500. D. Van Nostrand Company, Inc. New York.

1 teaspoonful = 5 ml; 1 ml = a slight $\frac{1}{4}$ teaspoon

1 quart = 920 ml; 1 l = 1 qt. + appx. $\frac{1}{3}$ cup

solutions should be prepared carefully, do not contaminate by using the same container for different solutions without rinsing 3 times with distilled H_2O . Bean seed treated with chloranil; 2,3,5,6-tetrachloro-1,4 benzoquinone.

4. OBSERVATIONS:

From various elements, water, air and light, a green plant produces food. (Food is any source of energy which can be used by animals.)

5. CONCLUSIONS:

None of the materials used, except the seed, contain energy in a usable form. The plants contain food, therefore the plants must make the food. The usable energy in the food is the energy (unusable) of light. Food chains—ultimate source is green plants. The process of photosynthesis was studied. The effect of six of the ten main elements was observed and it was concluded all the elements found in soil are needed. The life cycle of plants was observed and studied as the plant matured. A notebook and diagrams recorded this information.

A tape-recording was made and is available. Pictures and slides are also available.

Teachers References:

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Audio-Visual Aids Used:

FILMSTRIPS:

The Story of Seeds, Eye Gate House, Inc.

Plants and Seeds, Eye Gate House, Inc.

Plants, Eye Gate House, Inc.

Soil and Its Uses, Eye Gate House, Inc.

FILM:

Mr. Sun, Bell Telephone Company

PICTURES:

Basic Seven Food Series, The American Institute of Baking, Chicago, Illinois.

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(Continued from page 72)

e. *An appropriate in-service program.* The vast number of teachers who acknowledge their fears and inadequacies in teaching science, deserve a well-planned appropriate in-service program. Such programs are often scheduled after school. Many teachers approach these with fatigue but eagerness. They deserve to find things happening there that are appropriate to their needs.

f. *Some time to teach science.* Each year we continue to add to the curriculum. What shall we take away? The program is already too full for comfort and learning. There are things that demand energy and time from the elementary teacher that are nonsense. They contribute little toward achieving the goals of elementary education. A year concentration on taking away some of these might leave room for others more essential. Be that as it may, there must be definite time in the week's schedule for science instruction just as there is for any other basic subject or it will not be taught. Somehow teachers need help to find time for science.

There is evidence throughout the country of real progress in the improvement in science teaching in the elementary schools. We can be cheered by this but certainly not complacent for there are still many children without good science instruction. There are still many teachers who need considerable improvement before they can be as excellent as they should and would like to be.

We have explored only a few elements that unite to make excellence. Each teacher adds to this list and places his own emphasis on those important for his consideration.

Relativity

(Continued from page 79)

Relativity of Time

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Relativity

(Continued from page 86)

In the following example you can point out how time is different for different observers at different positions.

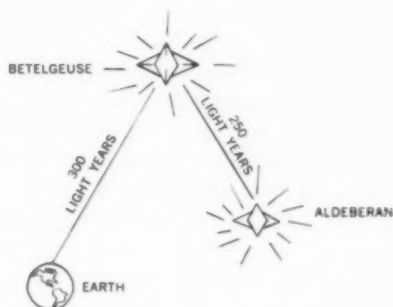


FIG. IV

To illustrate, consider Betelgeuse in the constellation Orion, the Hunter, and Aldeberan in Taurus, the Bull. Betelgeuse is about 300 light years from earth, and about 250 light years from Aldeberan. This means that a beam of light traveling at 186,000 miles/second would take 300 and 250 years to reach its respective targets.

Now imagine that Betelgeuse should suddenly go dark on the night of July 4, 1961. We on earth would not see Betelgeuse disappear on this date. The astronomers of the future would record this event on July 4, 2261, since the star is 300 light years away from the earth. However, an observer on Aldeberan would note the occurrence on the night of July 4, 2211, since Aldeberan is 250 light years from Betelgeuse.

We have shown here that the single event of the explosion is not simultaneous to the three places, since for each position the event occurs at a different time.

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 KROGDahl, WASLEY S., *The Astronomical Universe*, Macmillan, 1952.

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25 College Scholarships Among New Awards For Future Scientists of America Program

WASHINGTON (Special)—The National Science Teachers Association (NSTA) has announced that under the 1961-62 Future Scientists of America Awards program high-school students will be able to compete for \$250 college scholarships for excellence in scientific projects in addition to other awards totalling \$10,000.

Robert Carleton, NSTA executive secretary, said in announcing the expanded FSA Awards program, that this next year 25 college scholarships will be awarded to student winners in the 11th and 12th grades. This is the first year that this program has included awards of this kind.

In addition to the scholarships, recognition awards will also be given for outstanding scientific projects. Winners in this category will receive bronze and silver medallions and student and school certificates for grades seven through 12.

Teachers may obtain information, entry materials, and program instructions by writing directly to Future Scientists of America, 1201 16th St., N.W., Washington 6, D.C. Written reports of the students' projects must be submitted not later than March 31, 1962.

The Future Scientists of America Awards program is conducted by NSTA and is co-sponsored by a number of scientific, engineering, and technological societies, and trade associations.

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NEW BOOKS

Modern Elementary School Science

By WILLARD J. JACOBSON and HAROLD E. TANNENBAUM, Bureau of Publications; Teachers College, Columbia University, New York; 1961; 194 pages; price \$2.25.

After having reviewed the previous monographs the reviewer looked forward to this publication because the area of elementary school science has been a most abused area as far as scope and sequence is concerned.

The first two chapters reviewed well-known ideas and materials and presents merely a background for the more specific recommendation. The important new ideas in this section concerned the goals of elementary science education:

The goal of elementary science education must be

1. Much more related to the entire world situation than previous goals have intimated.
2. General enough to be extended easily into the upper grade so as to give the K-12 sequence more unity and general direction.

The second section beginning with Chapter 3 is fresh and stimulating and a real contribution to the clarification of many of the problems that have existed in the elementary school curriculum for many years. These problems are all related to the general problem of scope and sequence. Success in the fulfillment of these recommendations rests, of course, with the teachers in a local situation, but the framework and direction is definite. Science from K-6 is handled by dividing all science into 6 broad areas to be covered at each grade level. These areas are each broken down into five sub-headings with each sub-heading to be taught at a different grade level.

For example, Area I—The Earth on Which We Live—has the following sub-headings:

1. Study of Rocks in Grade I
2. Study of Soils in Grade II
3. Study of Weather and Climate in Grade III
4. Study of Earth-Changing Surface in Grade IV
5. Study of History of the Earth in Grade V
6. Study of Earths Resources in Grade VI

Each grade will contribute a specific topic to each of six general areas; a plan which should avoid unnecessary duplication or repetition.

Besides listing these broad areas and sub-areas, the monograph divides each sub-area into specific details suggesting important generalizations to be kept in mind by the teacher and some key questions to be asked that might aid in the development of each sub-area. The suggestions are definite enough to give direction yet flexible enough for local groups to develop their own units, laboratory manuals, and workbooks.

(Continued next page)

New Books

(Continued from page 88)

Administrative organization is suggested to help assure the success of achieving the goals of science education. Alternate plans are suggested and discussed. An interesting section on materials and facilities is developed to offer pointers on the mechanics of carrying out the organizational plan. Evaluation of the result of science education in the elementary school is discussed by detailing the general aims previously mentioned. The reviewer believes that the monograph should be invaluable to experienced teachers who may not have had recent contact with the excellent textbooks in elementary science education or the benefit of recent research in the science areas. Any individual curriculum director or administrator, who likes the "whole story in a nutshell" would find this booklet excellent reading and a good framework within which to carry on fruitful faculty discussions leading to necessary curriculum changes or syllabi revisions.

DR. MARC A. SHAMPO
Associate Prof. of Education
Duquesne University

The Atoms Within Us

By ERNEST BOREK. Columbia University Press,
1961, Pp. 272; price \$5.00.

This book concerns the biochemist of the present and the past; the scientific problems he has solved and the

ones he is attacking. These pages are filled with interesting detail concerning some of the great discoveries such as the isolation of urease, the first enzyme to be crystallized, the vitamins, nucleic acids, the sequence of amino acids in the insulin molecule and many others. Not only are the implications of these discoveries discussed but the personalities responsible for them are brought to the readers attention.

The author devotes a considerable portion of the latter section of the book to some of the major problems concerning the biochemist today: cancer, protein biosynthesis, mechanism of heredity, biochemistry of the brain. With this he asks some interesting biochemical questions, for example, Is memory part of a molecular complex? How is memory perpetuated? Finally, the author seriously questions whether this nation is fully utilizing its resources in the battle against disease. He states that prior to 1940 our nation's annual bill for funeral flowers was 100 million dollars and at the same time only 45 million dollars was spent on medical research. Would it not be advantageous to spend more on the living than on the dead! This book is recommended to all who have an interest in the mechanism of life and particularly those who are about to embark on a career of biology, chemistry or physics.

ANDREW J. GLAID
Associate Professor of Chemistry
Duquesne University

(Continued next page)

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New Books

(Continued from page 89)

An Introduction to Astronomy

By ROBERT H. BAKER. 6th Edition, D. Van Nostrand Company, Inc., Princeton, New Jersey

Dr. Baker has presented an excellent introduction to the wonders of astronomy. His material is covered in a detailed and clear manner. The latest findings in space research are included in the text. The Van Allen radiation belt advanced insight into gas streams in our galaxy are but two of the recent discoveries discussed by Dr. Baker.

Each chapter provides questions for the student to discuss and use as an aid in clarifying points on the material presented.

The text provides added appeal by presenting many pictorial examples and graphic presentations of celestial bodies.

An Introduction to Astronomy is an excellent source of information and would provide the beginning student in astronomy with a sound background.

DR. JOHN R. O'DONNELL
Associate Professor of Education
Duquesne University

The Mediterranean Lands

By D. S. WALKER. John Wiley & Sons, Inc., New York, 1960. pp. 524

The Mediterranean Lands presents a scholarly approach to the rich environmental and geographical features of the Mediterranean. Such an approach makes this a valuable resource and instructional aid to the High School and College teacher.

This is an excellent book to place on your reading list and on your reference shelf. The school library should also have some copies for the research students interested in the Mediterranean Lands.

The Mediterranean Lands discusses in detail Spain, Portugal, Mediterranean France, Italy, Malta, Africa, The Balkan Peninsula, Albania, Greece, Turkey, Cyprus, The Arab Countries, Israel, Egypt and Libya.

JUANITA P. FORGE
Assistant Professor of Education
Duquesne University

Exploring Mathematics on Your Own

Booklet series. Webster Publishing Co., St. Louis, Mo. 1961. \$.69-.85

This series consists of 7 small booklets in print:

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These booklets, in general, are excellent surveys of various areas of mathematics for both the student and teacher. Each booklet contains descriptive material on the topic with simple exercises to perform and problems to solve. The answers to the problems are also available. For the most part the texts are well-illustrated and have a general appeal to the reader that the traditional approach often lacks. Reading levels and grade coverage vary for the booklets, but a range of grade levels for each booklet is suggested by the authors. The reviewer found *Exploring Mathematics on Your Own* enlightening, well written, and quite enjoyable.

MARC A. SHAMPO
Associate Professor
Duquesne University

History of the Earth

By KUMMEL, BERNHARD. Drawings by E. L. Gillespie, 610 pages, 462 illustrations, 23 charts, \$8.75, W. H. Freeman and Company, c 1961.

The author has created an interesting piece of work that presents the geologic history of the earth for each era since the Precambrian. The effect of the spatial distribution of rocks on the physical evolution of the earth has been developed. The sequential and evolutionary biology of the earth's flora and fauna has been imaginatively recreated. Correlation of the illustrative and subject material has been well done.

The index and type size make for easy location and reading of the contents. However, the binding is not durable enough to withstand the rigors of student life.

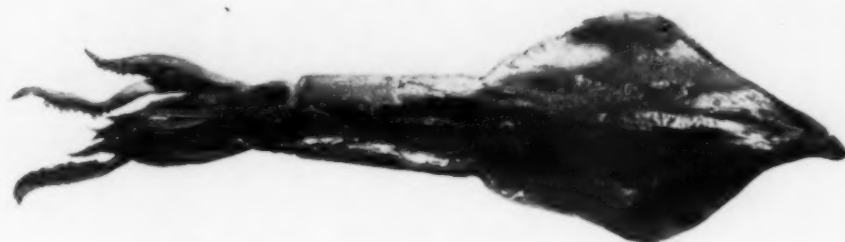
The author has a wide range of background experience and study to qualify his work. He is now an associate professor of geology at Harvard University.

This text would be suitable for use both as an introductory reference and a classroom subject book.

G. FREDERICK BEAL
Science Teacher
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Science Projects

(Continued from page 75)

- two loaves of bread—one made with yeast, and one made without, to dramatize the importance of yeast.
- (7) **GOOD DIET—POOR DIET:** Use a long sheet of brown wrapping paper and whatever art medium is desired. Divide the paper in half, lengthwise, with crayon, and in vertical sections. In the first top section, a child with a well-developed body; in the bottom section, a child with an under-developed body. In similar fashion, an arm with a well-developed muscle, an arm with a weak flabby muscle; child with good posture, child with poor posture, etc. The class may also keep record of diet of each student and chart the growth and development of each.
- (8) **HISTORY OF BREAD:** Depicting the type of Bread and how it was made through the ages, starting with primitive man and developing the idea through each major civilization including our present one. This will correlate with geography as there are many different kinds of bread and baking methods used in various locations in the world today.

The Synthesis

(Continued from page 73)

III.

The voltages were obtained with a high-frequency Tesla coil built by the students to generate up to 120,000 volts for sustained periods of time with break-down or over-heating. The all-important glass apparatus was designed to provide continuous circulation of the gaseous ingredients, with necessary safety features built into its construction. These included removable electrodes that could "pop" out, and a mercury dip-leg to accommodate fluctuations of pressure. A translucent, plastic screen was established in front of the apparatus for further protection. All air was flushed out of the apparatus by hydrogen in preparing for the first run. The gases were then introduced under reduced pressures totaling less than the atmosphere.

Generous assistance came from the staff of the Sinclair Research in Harvey, Illinois, without which the experiment could not have been carried to completion.

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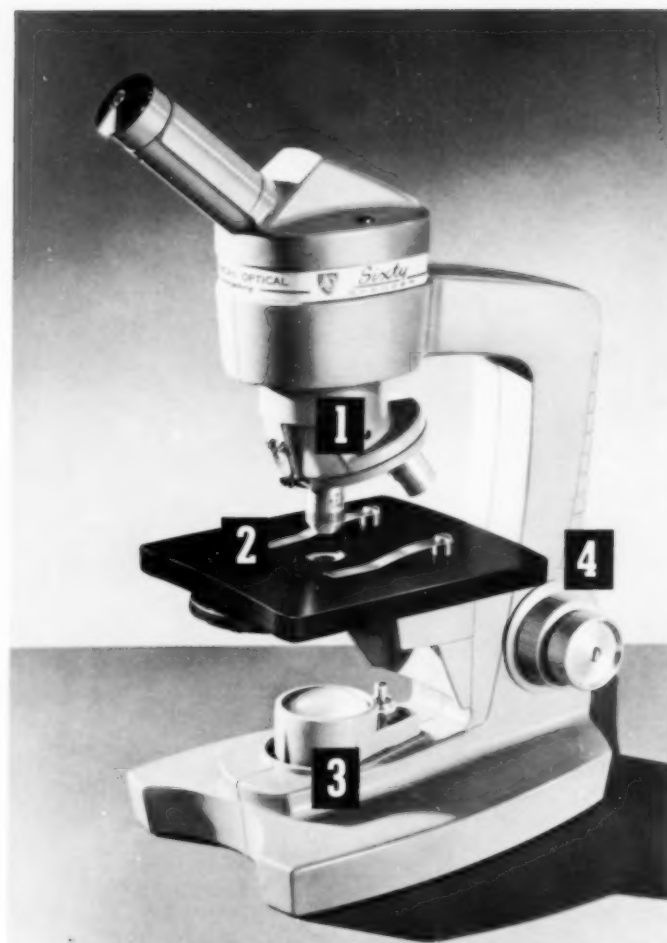
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The Synthesis

(Continued from previous page)

IV.

The experiment itself raises interesting and fundamental questions. What is the origin and nature of autocatalysis? What are the implications of the current view that "life" is an inevitable property of highly-organized matter? And, indeed, a further question arises, what is matter?

We should not draw too many conclusions from this experiment. For example, one cannot infer from such speculations as those here outlined that man does not transcend nature. Nor can one safely infer that the sum total of reality is what may be perceived by the senses.

Nevertheless, the Miller experiment, here repeated, may well be considered one day as a "classic"

in the history of biology. It surely commends itself by the simplicity of its theory and the beauty of its logic.

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The Undergraduate

(Continued from page 83)

in their ability to make contributions to a research problem of recognized scientific value. It seems doubtful to us that the same level of maturity in research can, for most students, be reached by isolated, unrelated research problems.

The first tangible result of the investigation was a paper embodying the work of five students which they wrote and presented at the Eastern Colleges Science Conference at Hunter College (New York City) on April 23, 1960, and at the Meeting-in-Miniature of the "Philadelphia Area Student Chemists Association" at LaSalle College on May 7, 1960. Six students cooperated in a similar work this Spring. They presented their paper at the PASCA Meeting-in-Miniature in April 1960, and two of them took it to Syracuse the next month to this year's Eastern Colleges Science Conference. This kind of experience is an invaluable adjunct to the actual research. It would seem, too, that the improvement which we noticed in the second paper had some correlation with the fact that its authors were the group who worked full-time the previous summer. N.S.F. was not mistaken in urging the value of concentrated and unbroken application to the work to reap the full benefits of the research experience.

A gratifying increase in both the number and quality of chemistry majors seems to have accompanied the initiation of the research program. (There is, as always, considerable fluctuation in the actual count by classes.) Of the six participants who had stipends under the first N.S.F. grant, three are doing full-time graduate study. A fourth is doing

part-time graduate work while working in industry. All have found their research experience of great practical help and those seeking positions in industry noted the interest of those interviewing them in their Research credits.

As with any research, peripheral problems never fail to suggest themselves and invite further investigation. From the simple kinetics problem using a colorimetric method of analysis, future work involving new methods in ion exchange, electrophoresis and possibly gas chromatography are already awaiting undergraduate participants. Full-time work will continue again this summer* with two students from last year's group introducing three underclassmen to the scope and methods of the work. Both the project director and N.S.F. request the participants to evaluate the program from a student's point of view at the end of each grant period. In addition to many of the points which I have already mentioned, one student made a comment which epitomizes the fascination of research for us all:

"In addition to these benefits, the work has been enjoyable. Discovering answers for the first time, attempting to correlate the answers, and realizing that you are contributing to something new in scientific knowledge is quite satisfying."

Actually the National Science Foundation Undergraduate Research Participation Program seems especially valuable for the smaller liberal arts colleges which cannot undertake or take advantage of the large, contract-type research program. We hope that this program will be further extended so that more colleges may feel the benefits we have experienced.

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HIGHLIGHTS

A total of 311,000 professional personnel were employed by colleges and universities in March 1958. About half—157,000—were scientists and engineers.

Of the 211,000 reported as faculty, 100,000 were scientists and engineers. Of the 100,000 nonfaculty professional personnel, 57,000 were scientists and engineers.

Nearly 40 per cent of the 157,000 science and engineering personnel were life scientists, about 25 per cent were physical scientists, and engineers and social scientists each represented less than 20 per cent.

About 70,000 of the science and engineering professional staff were reported as spending time on research activities. More than one-half of those engaged in research were nonfaculty.

There was a high degree of concentration of faculty and nonfaculty personnel in the large universities; they employed over 50 per cent of all staff. About 25 per cent of professional staff engaged in research were employed by less than 10 per cent of the institutions.

The trend in the employment of scientific and engineering faculties at colleges and universities has been up—an increase of one-third from 1954 to 1958. This rate of increase has been somewhat more rapid than that for total staff—34 per cent in science and engineering compared with 30 per cent for total staff.

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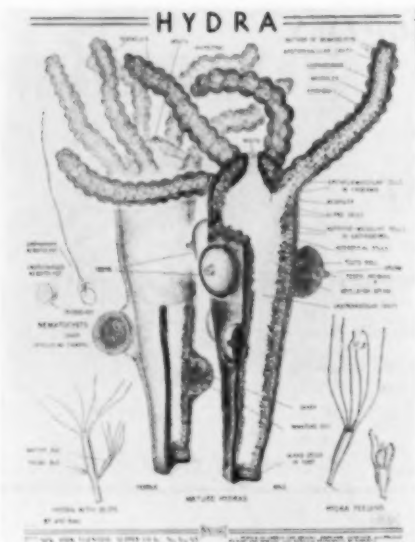
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